

IEEE • Virus Anatomy Another Manhattan Project Book Picks

SPECTRUM

NOVEMBER 2001

SPECIAL REPORT

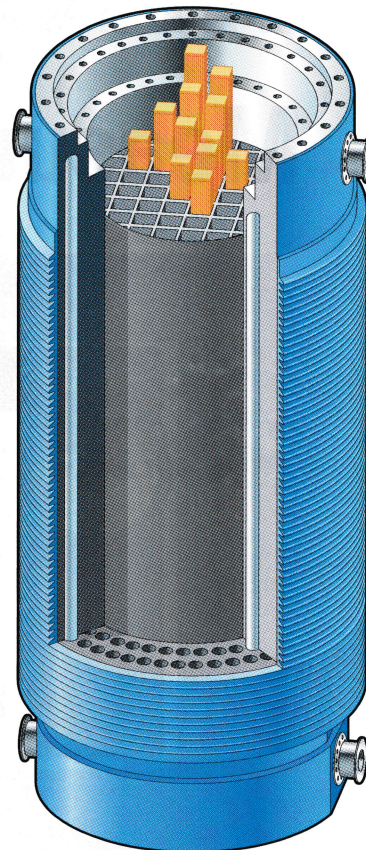
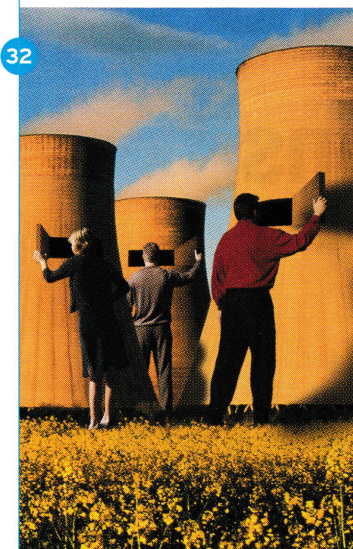
Nuclear Power Gets a Second Look



www.ieee.org \$4.95



 **IEEE**



FEATURES

NUCLEAR POWER SPECIAL REPORT

32 Nuclear Power Gets a Second Look

By Tekla S. Perry California blackouts, concern about global warming, and the 11 September tragedy are turning attention anew to nuclear power.

34 Pragmatic Concerns Fuel Nuclear Support

By Steve Miller Sentiment in favor of nuclear power may be increasing, note U.S. public opinion polls. But the results are mixed, and opposition in Europe continues.

37 Pebble-Bed Design Returns

By Jenny Weil A design developed decades ago in Germany and the United States is making a surprising return and could jump-start a nuclear revival.

42 ReactorLand: A Board Game

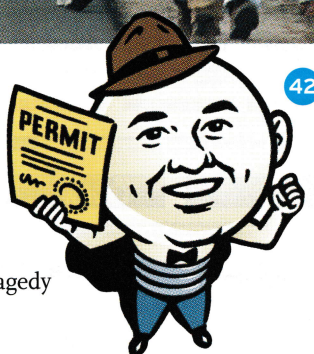
By Jason Makansi Players try to finance, license, and build a nuclear reactor in less time than the 5–10 years needed in real life.

44 Canned Heat

By Glenn Zorpette A temporary fix for the nuclear waste problem—storing the material in giant casks—has emerged. But a permanent solution continues to elude the industry.

48 Extending Life By Half

By David P. Amber Nuclear power plants were originally given 40 years of life. But now they're being relicensed to run for 20 years more.



52 Core Studies Make Comeback

By David P. Amber University nuclear engineering departments have stepped up recruiting efforts, aided by cash, healthy job prospects, and the promise that nuclear isn't dead yet.

54 Unconventional Nuclear Weapons

By Glenn Zorpette & Steve Miller Counterterrorism officials are re-evaluating scenarios that once seemed implausible. Among them: crashing a jumbo jet into a nuclear reactor and lacing a conventional bomb with intensely radioactive nuclear waste.

SOFTWARE

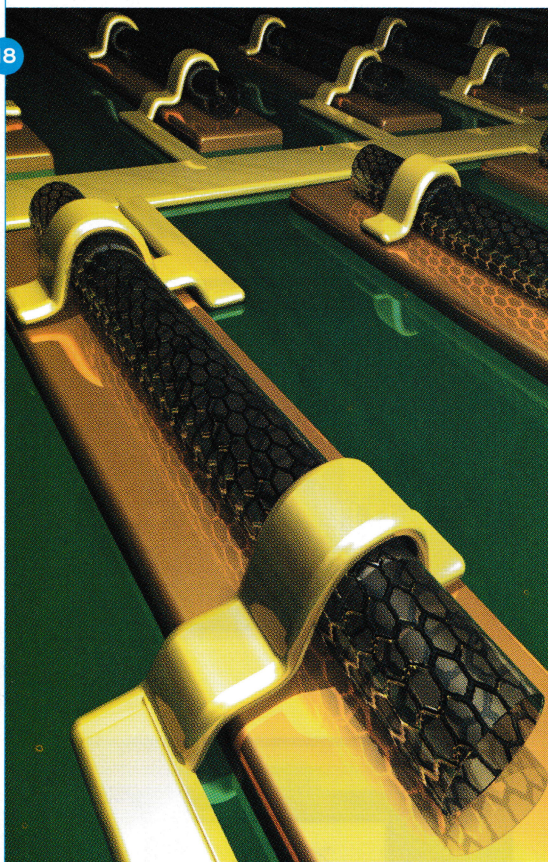
56 Anatomy of Malice

By Stephen Cass What makes computer viruses tick? How do network worms spread? *IEEE Spectrum* looks under the hood of malicious software.

ON THE COVER: Photo-illustration by Steven Belcher. Cooling towers photograph: FPG International

More information regarding articles in *IEEE Spectrum* is available on Spectrum's home page on the Web: <http://www.spectrum.ieee.org>

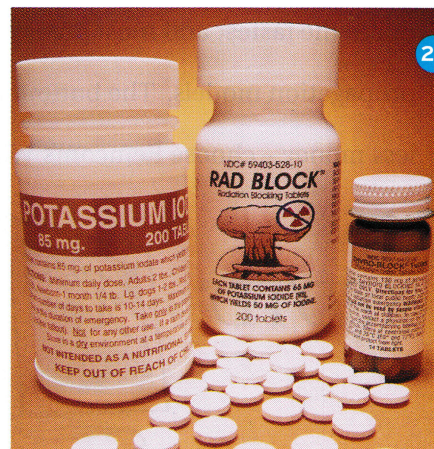
18



70



61



24

DEPARTMENTS

7 CONTRIBUTORS

9 SPECTRAL LINES

10 FORUM

14 SPEAKOUT

A Counterterrorist Manhattan Project
Technology to counter terrorism deserves top priority.

By Michael Vatis

15 Extreme Ultraviolet Lithography: Will it be Ready in Time? Technical obstacles could lead to a schedule slip.

By G. Dan Hutcheson

NEWS ANALYSIS

18 Steps Toward Molecular Electronics

19 Payne's Key to All-Optical Routers

21 At Last, a Magnetic Refrigerator?

23 Florida's High-Tech Haven

24 Thyroid-Blocking Drug in Demand

27 Bush and Congress Converge
On Anti-Terrorist Legislation

28 CO₂ Makes Fillings for Chip Cavities

29 World's Most Powerful Supercomputer

RESOURCES

61 CAREERS

Appraising the Performance of Performance Appraisals Alternatives emerge for giving employees feedback, raises. By Harry Goldstein

When Disaster Strikes There's no substitute for backup facilities. By Jean Kumagai

65 BOOKS

Editors' Picks

69 WEBSIGHTS

Remailers Elude E-mail Surveillance Keeping whom you correspond with secret. By Steven M. Cherry

70 TOOLS & TOYS

A DVD Changer for the Car
By Elizabeth A. Bretz

95 TO PROBE FURTHER

96 REFLECTIONS

The Telecom Dark Ages

Are engineers victims of, or contributors to, the present malaise?

By Robert W. Lucky

IEEE SPECTRUM (ISSN 0018-9235) is published monthly by The Institute of Electrical and Electronics Engineers, Inc. All rights reserved. © 2001 by The Institute of Electrical and Electronics Engineers, Inc., 3 Park Avenue, New York, NY 10016-5997, U.S.A. Canadian Post International Publications Mail (Canadian Distribution) Sales Agreement No. 0338087. Cable address: ITRIPLEE. Fax: +1 212 419 7570. INTERNET: a.rosenblatt@ieee.org. ANNUAL SUBSCRIPTIONS. IEEE Members: \$11.50 included in dues. Libraries/institutions and nonmembers: \$195. POSTMASTER: Please send address changes to IEEE Spectrum, c/o Coding Department, IEEE Service Center, 445 Hoes Lane, Box 1331, Piscataway, NJ 08855. Periodicals postage paid at New York, NY, and additional mailing offices. Canadian GST #125634188. Printed at W224 N3322 Duplainville Rd., Pewaukee, WI 53072-4195, U.S.A. IEEE Spectrum is a member of the Audit Bureau of Circulations, the Magazine Publishers of America, and the Society of National Association Publications.



STEVEN BELCHER [cover design] discovered a knack for photography after getting a B.S. in electrical engineering at the University of California in Los Angeles and doing a stint in the defense contracting industry. Shifting his career path toward the art world, he created the first Photoshop boutique in Los Angeles.

MICHAEL VATIS [p. 14] is the director of the Institute for Security Technology Studies at Dartmouth College, in Hanover, N.H., and Of Counsel with the law firm of Fried, Frank, Harris, Shriver & Jacobson in Washington, D.C. He was formerly a senior U.S. government official, working in the Departments of Justice and Defense and at the Federal Bureau of Investigation.

G. DAN HUTCHESON (SM) [p. 15] is president of VLSI Research Inc., a marketing and consulting firm in San José, Calif. In the 1980s he developed the semiconductor industry's first financial models for cost-of-ownership and for cost-optimization of factories.

ALEXANDER HELLEMANS [p. 18], a science and technology writer living in Pro-cida, Italy, contributes regularly to the journals *Science* and *Nature*. He is the coauthor, with Bryan Bunch, of *The Timetables of Science* and *The Timetables of Technology* (Simon & Schuster, New York, 1991 and 1994).

JUSTIN MULLINS [p. 19] freelances as a science writer based in Oxford, England. He is a consulting technology editor for *New Scientist*.

MARK INGEBRETSEN [p. 21] is a columnist with the financial Web site, TheStreet.com. He is currently at work on a book about the Nasdaq stock market.

MARK SCHROPE [p. 23] writes science features as a freelancer, based in Melbourne, Fla. His work has appeared in *New Scientist*, *Nature*, and *Popular Science*.

SANYIN SIANG [p. 27] is with the American Association for the Advancement of Science in Washington, D.C.

STEVE MILLER [p. 34 and p. 54] became a freelance science writer after 23 years as an analytic chemist. Based in State College, Pa., he also edits the newsletter *Superconductor Week*.

JENNY WEIL [p. 37] covers regulatory and business affairs in the nuclear energy industry as managing editor for *Inside NRC*, a newsletter published in Washington, D.C., by Platts, a division of the McGraw-Hill Companies.

JASON MAKANSI [p. 42] is president of Pearl Street Inc., a technology deployment services firm in St. Louis, Mo. (<http://www.pearlstreetinc.com>). Between 1994 and 2000, he was editor-in-chief of *Power*, a McGraw-Hill magazine. His book, *Investing in the Electricity Economy*, will be published by John Wiley & Sons next spring. In December 2000, Makansi was featured in The History Channel's program, "Modern Marvels: Power Plants."

ROBERT W. LUCKY (F) [p. 96] is vice president for applied research at Telcordia Technology, in Red Bank, N.J. (rlucky@telcordia.com).

EDITOR SUSAN HASSLER

MANAGING EDITOR ALFRED ROSENBLATT

SENIOR FEATURES EDITOR LINDA GEPPERT

SENIOR NEWS EDITOR WILLIAM SWEET

SENIOR ENGINEERING EDITOR MICHAEL J. RIEZENMAN

SENIOR EDITORS TEKLA S. PERRY, GLENN ZORPETTE

SENIOR ASSOCIATE EDITORS ELIZABETH A. BRETZ,
STEVEN M. CHERRY, HARRY GOLDSTEIN,
JEAN KUMAGAI

ASSOCIATE EDITORS STEPHEN CASS, SAMUEL K. MOORE

ASSISTANT EDITOR WILLIE D. JONES

CHIEF COPY EDITOR MARGARET EASTMAN

COPY EDITOR SALLY CAHUR

EDITORIAL RESEARCHER ALAN GARDNER

ADMINISTRATIVE ASSISTANT NANCY T. HANTMAN

CONTRIBUTING EDITORS ALEXANDER HELLEMANS,

MARK INGEBRETSEN, ROBERT W. LUCKY,

JUSTIN MULLINS, SANYIN SIANG,

MARK SHROPE, JENNY WEIL

IEEE FOUNDATION JOURNALISM INTERN DAVID P. AMBER

ADMINISTRATOR, EDITORIAL SUPPORT SERVICES RITA HOLLAND

SENIOR EDITORIAL ASSISTANTS RAMONA GORDON,
DESIREE NOEL

ART DIRECTOR MARK MONTGOMERY

ASSISTANT ART DIRECTOR MICHAEL R. VELLA

PRODUCTION DIRECTOR ALAN B. SCHAFER

EDITORIAL PRODUCTION MANAGER ROY CARUBIA

ELECTRONIC LAYOUT ARTIST DARLENE ALBERTI

TECHNICAL GRAPHIC ARTIST JIM HANKARD

IEEE MEDIA

PUBLISHER JAMES A. VICK

ASSOCIATE PUBLISHER, SALES
& ADVERTISING DIRECTOR: MARION DELANEY

BUSINESS DEVELOPMENT MANAGER,
SPECTRUM ONLINE MICHAEL BURYK

BUSINESS MANAGER ROBERT T. ROSS

MARKETING & PROMOTION MANAGER BLANCHE MCGURR

MAIL LIST SALES MANAGER ILIA RODRIGUEZ

LIST SALES ASSISTANT SIMRA DAVIS

ADMINISTRATIVE ASSISTANT MALINDA BELL

SECRETARY SHERIE GRAVES

ADVERTISING SALES +1 212 419 7760

ADVERTISING PRODUCTION SUPERVISOR FELICIA SPAGNOLI

ADVERTISING PRODUCTION COORDINATOR NICOLE PLEASANTS

ADVERTISING PRODUCTION ASSISTANTS DEBORAH GRANT,
DEBORAH TOMARO

ADVERTISING PRODUCTION +1 732 562 6334

STAFF EXECUTIVE, PUBLICATIONS ANTHONY DURNIAK

EDITORIAL BOARD

SUSAN HASSLER, *Chair*; TARIQ S. DURRANI, KENNETH R.
FOSTER, ALEX HILLS, W. DEXTER JOHNSTON JR.,
RAYMOND C. MONTGOMERY, S. TOM PICRAUX, MARK
SAFFIAN, LARRY STERN, LEWIS M. TERMAN, JILL TIETJEN,
HARRY L. (NICK) TREDENNICK, YERVANT ZORIAN

IEEE SPECTRUM HEADQUARTERS

3 PARK AVE., 17TH FLOOR
NEW YORK, N.Y., 10016-5997

TEL: +1 212 419 7555

FAX: +1 212 419 7570

www.spectrum.ieee.org

BUREAU: Palo Alto, Calif. TEKLA S. PERRY, +1 650 328 7570

BOOKS

Editors' Picks

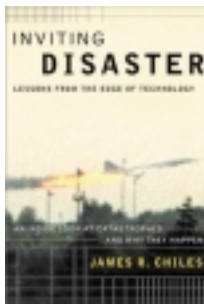
With the gift-giving season nearly upon us, *IEEE Spectrum* editors were polled for their best bets from the last 12 months of books

ENGINEERING

Inviting Disaster: Lessons from the Edge of Technology

James R. Chiles HarperBusiness, New York \$28

Usually more than one thing has gone wrong when a catastrophe affects our technologically complex world. This collection of short and usually understandable descriptions discusses the causes of such tragedies as the Challenger space shuttle disaster, the sinking of the Ocean Ranger oil-drilling rig, the Concorde crash in Paris, the faulty mirror in the Hubble telescope, the fiasco of the U.S. Navy's Mark 14 torpedo failures early in World War II, and many more. **AR**



How Stuff Works

Marshall Brain
Hungry Minds, New York
\$24.99

A good reference and a good read, *How Stuff Works* presents clear, well-illustrated explanations of how things work. Airplanes, cruise missiles, hybrid cars, batteries, file compression, digital cameras, routers, microwave ovens, sunglasses, radio-controlled toys, and more are covered. The book makes complex



ideas interesting and understandable to adults and kids alike. **EAB**

Exposing Electronics

Bernard Finn, editor
Gordon & Breach Science Publishing, Newark, N.J. \$23

Electronic artifacts are preserved in collections around the world. Finn's focus is the process by which they are collected and the museums in which many of them are kept. But his book is worth the price just for the high quality of its historical images and photographs of exhibits. **HG**

MILITARY

Weapons in Space

Karl Grossman, Michio Kaku
Seven Stories Press, New York \$6.95

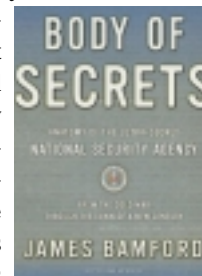
Published almost a year ago, *Weapons in Space* examines the 1967 Outer Space Treaty and the history of the Global Network against Weapons and Nuclear Power in Space. The Outer Space Treaty was created to ban space-based weapons of mass destruction and has been ratified by over 60 nations. The global network, founded in 1992, opposes the use of nuclear materials in space, even as a power source for interplanetary probes. At 80 pages, *Weapons* is no weighty legal tome but a speedy read and a useful introduction to the political backdrop to military and nuclear activity in space for the last three decades. **EAB**



Body of Secrets

James Bamford
Doubleday, New York \$29.95

With a staff of 38 000, the National Security Agency not only dwarfs the Central Intelligence Agency, but is the largest and most powerful intelligence agency in the world. Bamford's detailed examination of the U.S. agency and its reliance on satellites and the Internet for surveillance lifts the veil that normally shrouds its activities. **AR**

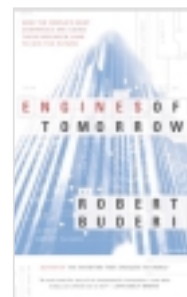


CAREER AND BUSINESS

Engines of Tomorrow: How the World's Best Companies Are Using Their Research Labs to Win the Future

Robert Buderl
Simon & Schuster, New York \$27.50

Former *Business Week* technology editor Robert Buderl takes a serious look at the role corporate research plays in long-term business success. Despite a perception that such activity has been dramatically scaled back in recent years, Buderl proves the opposite is true by taking us inside facilities at nine of the biggest innovators in the United States, Europe, and Japan: IBM, Siemens, NEC, Lucent Technologies, General Electric, Hewlett-Packard, Xerox, Intel, and Microsoft. **HG**



Disciplined Minds: A Critical Look at Salaried Professionals and the Soul-Battering System That Shapes Their Lives

Jeff Schmidt

Rowman & Littlefield, Lanham, Md.
\$26.95

Schmidt offers a provocative critique of how scientists, engineers, and other professionals are groomed to fulfill a specific function in society—that of maintaining the status quo—and, in the process, end up sidelining their own goals and ideals.

The book is both well researched and highly readable. Some readers may disagree with its conclusions, but everyone will recognize its descriptions of the often wrenching choices that today's professionals must make. JK

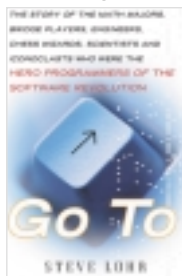
SOFTWARE

Go To: The Story of the Math Majors, Bridge Players, Engineers, Chess Wizards, Scientists and Iconoclasts Who Were the Hero Programmers of the Software Revolution

Steve Lohr

Basic Books, New York
\$27.50

Go To surveys the history of modern software, from the creation of the first successful high-level language, Fortran, and its compiler in the 1950s, through to the open source movement of today. The development of Unix and C, the rise of the graphical user-interface, and the creation of the spreadsheet are included among the events that shaped modern computing. Although some will argue with the choices of topics covered—for example, an entire chapter is devoted to Java, while no mention is made of the development of the Internet protocol—the book is full of fascinating details about an intangible creation that has had a very tangible impact on the modern world. SAC



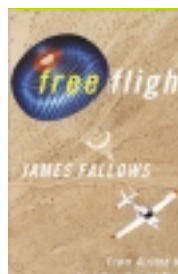
TRANSPORTATION

Free Flight: From Airline Hell to a New Age of Travel

James Fallows

Public Affairs, New York \$25

When published in June, Fallows' idea of developing a network of small air taxis, to be hailed like a cab at the airport arrivals curb, was dismissed by some in the industry as somewhat far-fetched and totally impractical. But in the aftermath of 11 September, private and corporate jet use is on a hot growth streak. The plane-taxi idea may not be a winner, but the notion of using smaller jets, booked as one might a car or rail cabin, is worth exploring. EAB



SPACE

Moon Lander

Tom Kelly

Smithsonian Institution Press,
Washington, D.C.
\$27.95

It's surprising that the man most responsible for the spindly Apollo lunar landers, Tom Kelly, hasn't told his story years before. Lucid and engaging, he tells how his team at Grumman in Bethpage, Long Island, went from paper studies to delivering hardware that would help change history. Beyond historical interest, the book has lessons for anyone involved in a large project at the cutting edge of technology. SAC



COMMUNICATIONS

Virtuality Check:

Power Relations and Alternative Strategies in the Information Society

François Fortier

Verso, London \$23

Information and communications technologies (ICTs), such the Internet or videoconferencing, are often glorified as

an instrument of a more efficient economy and as the electronic enabler of participatory democracy. Fortier thinks differently. He believes that corporations actually nurtured them as a means of political and economic control. In *Virtuality Check*, he explores the ways in which the technologies are used to subjugate workers, manipulate the consumer, and extend media monopolies, while leaving just enough room for the Slashdots and Alternets of the world to weave together some feeble resistance. HG



SCIENCE

Emergence: The Connected Lives of Ants, Brains, Cities, and Software

Steven Johnson

Scribner, New York \$25

When his online magazine *Feed* went belly up last year, editor Steven Johnson had a lot of extra time on his hands. The devil made work for them: *Emergence*, his followup on 1997's *Interface Culture*. *Emergence* explores the various forms of interconnectivity as it has evolved over the years, from ants that organize themselves to act as a single entity to computer programs that produce their own software offspring. HG



The Book of Nothing: Vacuums, Voids, and the Latest Ideas About the Origins of the Universe

John D. Barrow

Pantheon Books, New York \$27.50

Part history, part modern cosmology, and part humor, this book delves into the understanding of Nothingness, both mathematical and physical. From the

